Appl No.: 10/665,339

Atty. Dkt. UCF-397CIP

Amendment to the Claims:

This listing of the claims will replace all prior versions, and listings, of claims in the application.

Listing of Claims:

Claim 1 (Currently amended). A method of efficiently generating holograms from photo-thermo- refractive (PTR) glasses having a diffraction efficiency of at least approximately 90%, comprising the steps of:

providing a PTR glass blank having a total contamination with iron and heavy metals of a few ppm ~~below 5 parts per million~~;

exposing the PTR glass blank with a UV light source or other source of ionizing radiation to create precursors of nucleation centers which are color centers and ions with changes in valence states;

generating a visible light having an intensity greater than approximately 10 MW/cm^2;

exposing the UV exposed PTR glass blank containing precursors of nucleation centers with the high intensity ~~a high-power Visible~~ visible light ~~source~~ greater than approximately 10 MW/cm^2 to decrease concentration of the precursors to decrease the rate of crystallization at the development stage to increase a refractive index in the PTR glass after exposure to the visible light to record the hologram, wherein the visible light exposure of the UV exposed PTR glass blank ~~results in partial~~ causes a nonlinear transformation of nucleation centers;

thermal treating the PTR glass exposed to both the UV and ~~high-power Visible~~ visible radiation to provide phase transformation depending on an amount and intensity of ~~a~~

~~power density of the high-power Visible~~ visible radiation to allow crystal growth in the UV exposed area using a nonlinear mechanism for destruction of nucleation centers in the area exposed to visible light;

cooling the thermal treated PTR glass to room temperature to provide refractive index variations according to the amount and intensity ~~the power density~~ of the ~~high-power Visible~~ visible radiation, wherein a difference between refractive indices in the UV exposed areas and the UV and visible light exposed areas allows hologram recording by visible light radiation; and

replaying the hologram from the exposed and thermal treated PTR glass by long wavelength radiation.

Claim 2 (Canceled).

Claim 3 (Previously presented). The method of claim 1, wherein the step of exposing with UV light source includes a range of approximately 280 to approximately 350 nm.

Claim 4 (Previously presented). The method of claim 1, wherein the step of exposing with the UV light source is approximately 325nm.

Claim 5 (Currently amended). The method of claim 1, wherein the step of exposing with ~~Visible~~ visible light source includes a range of approximately 450 to approximately 600 nm.

Claim 6 (Currently amended). The method of claim 1, wherein the step of exposing with a ~~Visible~~ visible light source includes: approximately 532 nm.

Claim 7 (Currently amended). The method of claim 1, wherein the step of exposing with a ~~Visible~~ visible light source includes: a high ~~power~~ intensity source generating at approximately 10 megawatts/ cm^2 to approximately 100 gigawatts/ cm^2.

Claim 8 (Currently amended). The method of claim 7, wherein the high ~~power~~ intensity visible light is ~~source generates at~~ approximately 100 megawatts/ cm^2.

Claim 9 (Currently amended). The method of claim 7, wherein the high ~~power~~ intensity visible light is ~~source generates at~~ approximately 10 gigawatts/ cm^2.

Claim 10 (Original). The method of claim 1, wherein the step of generating a hologram includes the step of:

generating a simple hologram having substantially planar surfaces of equal refractive index.

Claim 11 (Original). The method of claim 1, wherein the step of generating a hologram includes the step of:

generating a complex hologram having substantially curved surfaces of equal refractive index.

Claim 12 (Original). The method of claim 1, wherein the step of thermal treating includes the step of:

thermal treating the PTR glass in a temperature region ranging from approximately 480 to approximately 580°C for a period of from a few minutes to several hours appropriate for phase transformation.

Claim 13 (Currently amended). A method of generating optical components from photo-thermo-refractive (PTR) glasses, comprising the steps of:

providing a PTR glass blank having a total contamination with iron and heavy metals of a few ~~below 5~~ parts per million;

exposing the entire PTR glass blank with a UV light having a wavelength within the limits of the UV spectrum to produce precursors of nucleation centers which are color centers and ions with changes in valance states;

generating a high intensity visible light greater than approximately 10 MW/cm^2;

exposing the UV exposed PTR glass with ~~a~~ the high-intensity visible ~~power Visible~~ light ~~source~~ for optical excitation of the color centers to partially bleach the color centers to record a phase hologram by refractive index modulation, the partial bleaching being non linear due to the high-intensity visible ~~power Visible~~ light exposure;

thermal treating the UV and ~~Visible~~ visible light exposed PTR glass; and

cooling the thermal treated PTR glass to generate a holographic optical component from the thermal treated PTR glass for a visible region.

Claim 14 (Previously presented). The method of claim 13, wherein the cooling step to generate the optical component includes the step of:

generating the optical component from one of a lens or multi-lens objective, a combination of a prism or mirror with lenses, and a divergent/convergent beam splitter/combiner.

Claim 15 (Currently amended). An apparatus comprising:

a photo sensitive refractive (PTR) glass;

a UV source for exposing the PTR glass to produce a PTR glass having photosensitivity to visible light caused by the UV exposure to create precursors of nucleation centers which are color centers and ions with changes in valance states in the PTR glass, the PTR glass having a total contamination with iron and heavy metals of a few ~~below 5~~ parts per million;

a visible light source for exposing the UV exposed PTR glass to high intensity visible ~~Visible~~ light greater than approximately 10 MW/cm^2 to decrease concentration of the precursors to decreast the rate of crystallization at the development stage to increase a refractive index in the PTR glass after exposure to the visible light for non linear transformation ~~bleaching~~ of the ~~color~~ nucleation centers;

~~means~~ a heating unit for thermal treating the UV and visible ~~Visible~~ light treated PTR glass to provide phase transformation depending on an amount and intensity of visible radiation to allow crystal growth in the UV exposed area using a nonlinear mechanism for destruction of nucleation centers in an area exposed to visible light to fabricate a hologram or

a phase plate from the PTR glass for a visible region, the hologram generated by refractive index modulation; and

means for using the PTR glass as one of a refractive and a diffractive volume holographic optical element based on modulation of a refractive index.

Claim 16 (Previously presented). The apparatus of claim 15, wherein the UV exposure includes a range of approximately 280 nm to approximately 350 nm.

Claim 17 (Previously presented). The apparatus of claim 16, wherein the UV exposure is approximately 325 nm.

Claim 18 (Currently amended). The apparatus of claim 15, wherein the visible ~~Visible~~ light exposure includes a range of approximately 450 nm to approximately 600 nm.

Claim 19 (Currently amended). The apparatus of claim 18, wherein the visible ~~Visible~~ light exposure is approximately 532 nm.

Claim 20 (Previously presented). The apparatus of claim 15, wherein the thermal treatment means includes a range of approximately 480 to approximately 580°C for a period of from a few minutes to several hours appropriate for phase transformation.

Claim 21 (Previously presented). The apparatus of claim 15, wherein the holographic optical element includes: a simple hologram having substantially planar surfaces of equal refractive index.

Claim 22 (Previously presented). The apparatus of claim 15, wherein the holographic optical element includes: a complex hologram having substantially curved surfaces of equal refractive index.

Claim 23 (Currently amended). A method of generating refractive optical elements from photo-thermo- refractive (PTR) glasses, comprising the steps of:

providing a PTR glass having a total contamination with iron and heavy metals of a few ~~below 5~~ parts per million;

exposing PTR glass with a source of UV radiation for generation of precursors of nucleation centers which are color centers and ions with changes in valance states;

generating a visible light having an intensity greater than $10MW/cm^2$;

exposing the UV exposed PTR glass with a high-intensity visible ~~power Visib~~le light source to decrease concentration of the precursors to decrease the rate of crystallization at the development stage to increase a refractive index in the PTR glass after exposure to the visible light for a nonlinear transformation of nucleation centers ~~partial bleaching of the color centers~~;

thermal treating the UV and visible ~~Visible~~ light exposed PTR glass to provide phase transformation depending on an amount and intensity of visivle light radiation to allow crystal growth in the UV exposed area using a nonlinear mechanism for destruction of

nucleation centers in the area exposed to visible light ~~for spatial modulation of a refractive index~~, wherein after thermal treatment a refractive index in the UV and Visible light exposed area is higher than in a single exposed area and lower than in unexposed areas; and

replaying a hologram from the exposed and thermal treated PTR glass.

Claim 24 (Original) The method of claim 23 wherein the source of ionizing radiation is a UV light source.

Claim 25 (Previously presented). The method of claim 23, wherein the refractive optical elements are lenses, waveguides, waveguide arrays, a multiplexer, demultiplexer and a combination multiplexer/demultiplexer devices.